

PHYSICAL UPLINK CONTROL CHANNEL OPTIMIZATION

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is related to and claims the priority of U.S. Provisional Patent Application No. 61/647,102 filed May 15, 2012, which is hereby incorporated herein by reference in its entirety.

BACKGROUND

[0002] 1. Field

[0003] Communication systems, such as the long term evolution (LTE) of the third generation partnership project (3GPP) may benefit from various optimizations, such as optimizations related to smart phone technology. More particularly, diverse data applications may benefit from enhancements such as physical uplink control channel optimization.

[0004] 2. Description of the Related Art

[0005] LTE radio access network (RAN) enhancements for diverse data applications can include, for example, providing improved always-on connectivity. For example, mechanisms at the RAN level may be needed to enhance the ability of LTE to handle diverse traffic profiles. Under such traffic loads, the improvements may allow for better trade-offs to be achieved when balancing the needs of network efficiency, UE battery life, signaling overheads, and user experience/system performance.

[0006] In current LTE systems, a physical uplink control channel (PUCCH) resource allocation is configured by a radio resource controller (RRC) in semi-static way. For example, the RRC reconfiguration message may take up to tens or one hundred milliseconds to take effect. Once configured, the allocated resource is reserved and can conventionally be changed only via RRC reconfiguration, which is at the cost of RRC signaling. In practice, such RRC reconfiguration procedure happens rarely, even when user equipment (UE) traffic characteristic is changed, to avoid signaling overhead.

[0007] For example, scheduling request (SR) resource can be configured by an evolved Node B (eNB) in an initial stage after an RRC establishment procedure. If a long periodicity is configured, the configured periodicity may not fit if real-time application starts, such as voice over internet protocol (VoIP) or gaming. Otherwise if a short periodicity is configured, most of SR resource may be wasted. RRC reconfiguration can be used to adjust PUCCH configuration. In certain cases, however, RRC reconfiguration requires changing cell-specific parameters, such as physical resource block (PRB) numbers of channel quality indicator (CQI), to meet the demands. Such a change will impact all UEs in the cell and can potentially cause a significant effect on throughput during the transition phase. RRC reconfiguration thus can lead to reconfiguring a large number of user equipment (UEs) in a relatively short window of time.

[0008] 3GPP has a variety of approaches for providing PUCCH usage efficiency. One way is to extend periodicity. Another way is to provide a sharing mechanism whereby the same SR resource is allocated to multiple UEs. This approach assumes that each UE may have only a few packets transmission in background services. If multiple UEs happen to transmit a data packet at the same time, user contention over the same PUCCH resource and collisions may occur. In this case,

the eNB may be unable to identify which UE is transmitting the SR signal, leading to the need for a contention resolution mechanism.

[0009] Another approach is discontinuous reception (DRX) CQI masking, as described in 3GPP technical specification (TS) 36.331, which is hereby incorporated herein by reference. When a UE works in DRX mode, CQI transmission can be disabled in off-duration. This can permit another UE to transmit a CQI signal during the off-duration of the DRX-mode UE. In this way, multiple UEs can share a same CQI resource.

[0010] A further approach is PUCCH release with time alignment timer (TAT) configuration. In Release 8 (Rel-8), one timer, TimeAlignmentTimer, is used to control UL synchronization. Before TAT expiry, the UE can be indicated a new time advanced (TA) value to keep UL synchronization. If TA has not been updated until TAT is expired, this UE can enter out-of-sync mode, and can then release PUCCH resource. The eNB could set a small value for TAT to force UE into out-of-sync mode. For example, a minimum TAT value of 500 ms can be set.

SUMMARY

[0011] According to certain embodiments, a method may include configuring, with radio resource control signaling, a physical uplink control channel resource to one or more devices. The method may also include indicating to each device of the one or more devices, which part of the resource to use.

[0012] In certain embodiments, an apparatus may include at least one processor and at least one memory including computer program code. The at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus at least to configure, with radio resource control signaling, a physical uplink control channel resource to one or more devices. The at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus at least to indicate to each device of the one or more devices, which part of the resource to use.

[0013] An apparatus, according to certain embodiments, may include means for configuring, with radio resource control signaling, a physical uplink control channel resource to one or more devices. The apparatus may also include means for indicating to each device of the one or more devices, which part of the resource to use.

[0014] A non-transitory computer readable medium, in certain embodiments, may be encoded with instructions that, when executed in hardware, perform a process. The process may include configuring, with radio resource control signaling, a physical uplink control channel resource to one or more devices. The process may also include indicating to each device of the one or more devices, which part of the resource to use.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] For proper understanding of the invention, reference should be made to the accompanying drawings, wherein:

[0016] FIG. 1 illustrates three resource modes according to certain embodiments.

[0017] FIG. 2 illustrates seven resource modes according to certain embodiments.